STANISLAUS RIVER HABITAT USE INVESTIGATION

DRAFT STUDY PLAN
(FOR DISCUSSION PURPOSES ONLY)

Prepared by

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1.0 INTRODUCTION

The following study plan describes the proposed, technical approach, developed by the Fishery Foundation of California and Institute of Natural Systems Engineering, to conduct a pilot level investigation of fish/habitat/discharge relationships on the Stanislaus River. The goal of the study is to test and refine fish density and habitat classification methods, validate the statistical approach, and, on the basis of what we learn, make recommendations on how best to expand the effort to the entire LSR.

Hypotheses

1. There will be a difference in the amount of specific habitat types among surveys (flow regimes)?
2. Fish densities will differ among habitat types between and among survey reaches. (Note that direct comparison among flow regimes for fish density may not be possible because different species and life stages are likely to occur during the two survey periods. However, the two surveys should provide a clear picture as to what habitat types hold higher densities of specific species and life stages.)
3. Habitat differences can be used to predict differences in fish distribution within and among reaches.
4. The amount of each of the 6 possible meso-habitat types within and among reaches can be related to flow regime (survey periods).
5. The degrees of significance or strength of relationship for any of the above relationships will be statistically significant.
6. There will be a difference in microhabitat parameters between mesohabitat types.

2.0 BACKGROUND

2.1 Issue Statement

For the following study plan, the defined issue statement was:

Create geo-referenced maps that describe habitat use of Chinook salmon and rainbow/steelhead trout at two or more discrete flows on the Stanislaus River between Goodwin Dam and the confluence with the San Joaquin River. These maps shall quantify salmonid distribution and density, describe the corresponding physical habitat attributes, and identify discernible differences among these parameters between each discrete flow.

2.2 Study Design and Objectives

Study Design

The study area encompasses the Lower Stanislaus River (LSR) and its off channel habitats from Goodwin Dam, downstream to the confluence with the San

Joaquin River. It involves a statistical comparison of mesohabitat and fish distribution under two flows using empirical field data and 2-D modeling. The duration of the study is projected to be 12 months. The project as originally scheduled was to be conducted in February and April of 2006. Unseasonably high flows in the winter and spring of 2006 created conditions outside of the targeted flow range for the proposed study. The project was again postponed in 2007 as key logistical components evolved through stakeholder consultation. The field work associated with the project is now scheduled to commence in February and continue through May of 2008.

Study Objectives

Overall objective:

To determine fish habitat selectivity and meso habitat response to different operational flows from New Melones Dam into the LSR and to conduct a preliminary investigation to test survey methods, validate the data analysis approach, and define how best to expand the effort to the entire LSR between Goodwin Dam and the confluence with the San Joaquin River.

1. Select five, one-half mile sample reaches between Goodwin Dam and the San Joaquin River.
2. Create ArcMap GIS maps of meso habitat cells (polygons) for 5 sample reaches during two flows and classify each polygon using an acceptable classification system.
3. Measure density, length frequency, and species composition of fish within polygons.
4. From the data collected for each element above, create GIS database with layers that describe habitat and fish variables within polygons
5. Statistically describe variability in habitat use, availability, and quality within survey reach, among reaches, and within and among survey periods (flows).
6. Test a 2D hydrodynamic and habitat modeling approach at Knights Ferry and Lovers Leap during two flows.

3.0 METHODOLOGY

The methodological approach of determining habitat use during two flows is outlined in the following section. The approach consists of empirically mapping five, half mile reaches of the LSR via snorkel and ground surveys at two flows and testing a 2- D modeling approach at two, quarter mile reaches.

3.1 Mesohabitat Mapping and Snorkel Surveys

3.1.1 Site Selection

Mapping sites were initially chosen during the Spring of 2006 but were modified per stakeholder input in Winter of 2007. Per stakeholder suggestions the LSR will be broken down into 3 segments. The first step in mapping mesohabitats is selecting a minimum of five stream reaches within these segments that possess the following:

1. Stream reaches must be approximately 0.5 miles in length.
2. Reaches must be reasonably representative of the larger stream segment in terms of ambient habitat.
3. Reaches must be void of hazards deemed too great by the safety manager.
4. Reaches must have reasonable access so that work can be carried out within the allotted time.

It is usually impossible to meet all of the above criteria. In such cases, FFC will select the best possible reach using the above criteria. Tentative sites are as follows (figure 1):

Segment 1 (RM 47-58):

<u>2 mile bar (0.5 miles):</u>

Upper boundary: N37 50’41.362 W120 38’35.168

Lower Boundary: N37 50’28.760 W120 38’34.492

<u>Knights Ferry (0.5 miles):</u>

Upper boundary: N37 49’10.936 W120 39’48.810

Lower Boundary: N37 49’07.213 W120 40’15.215

<u>Lovers Leap *(0.5 miles)*:</u>

Upper boundary: N37 48’31.499 W120 41’35.339

Lower Boundary: N37 48’44.329 W120 41’59.636

Segment 2 (RM 34-47):

<u>Orange Blossom Bridge *(0.5 miles)*:</u>

Upper boundary: N37 47’18.173 W120 45’45.381

Lower Boundary: N37 47’30.705 W120 46’12.925

<u>Oakdale *(0.5 miles)*:</u>

Upper boundary: N37 46’15.725 W120 52’04.076

Lower Boundary: N37 46’12.276 W120 52’33.845

Segment 3 (RM 0-34):

<u>McHenry *(0.5 miles)*:</u>

Upper boundary: N37 44’59.694 W121 00’39.961

Lower Boundary: N37 45’15.060 W121 44’59.410

Figure 1. Tentative half mile sample reaches for Stanislaus River Habitat Use Investigation.

3.1.2 Habitat Mapping

Six mesohabitat types are proposed based on three water velocity categories and two categories for distance to edge (Table 1). Mesohabitat labels will follow an x.y code system based upon categories of the aforementioned variables (table 1). For example, a medium velocity, edge habitat would be classified as 1.1.

Table 1. Mesohabitat characterization criteria.

Velocity	Edge
0=0-0.5 fps	0=no edge (>2m from edge)
1=0.5-2.0 fps	1=edge (<2m from edge)
2=>2.0 fps	

One crew member (crew 1) will be responsible for determining mesohabitat boundaries and for measuring microhabitat variables within mesohabitats. Confining these activities to one highly trained person will, we assume, reduce observer bias that is often seen within multi person habitat surveys (Salow and Cross, 2004.). Crew 1 shall carry with him/her 50, pre-labeled, tyvex tags, Sharpie pens, and a depth rod.

Habitat surveys will start at the bottom of the 0.5 mile reach and proceed in an upstream direction. The two general mapping locations within a reach are those within 2 meters of an edge and those greater than 2 meters from an edge. Edge mesohabitat boundaries will be set based upon two criteria on the longitudinal axis and one for the lateral axis. Longitudinal margin boundaries will be set based velocity. Lateral edge boundaries or polygon widths will be set two meters from the nearest edge object. Longitudinal mid channel mesohabitat boundaries will be chosen primarily based upon velocity. Lateral no edge boundaries will be set by default at the edge boundary. Crew 1 will mark the upstream boundary of each mesohabitat with a tyvek tag. Irregularly shaped mesohabitats may be flagged and measured to capture the variability.

After each mesohabitat boundary is determined, crew 1 will survey the mesohabitat for microhabitat variables. Microhabitat variables will be written to a dive slate and transferred to the tyvex tag marking the upstream boundary. This process will continue upstream to the top of the reach.

- ***Microhabitat characterization***

Microhabitat variables within pre-defined mesohabitats will be estimated by the responsible crew 1 following mesohabitat boundary determination.

- ***Depth***

  Depth estimates will be determined both visually and with the aid of a depth rod (sec. 2.2). A minimum of six depths will be taken along the length of each mesohabitat. Depths will be taken in a zig zag pattern approximately 1 foot from the margin and one foot from the inside polygon boundary. Ave depths will be calculated at the end of the survey and assigned a category number (Table 2).

- **Substrate**

  Substrate will be visually categorized by crew 1 along the length of each mesohabitat polygon. Substrate composition in each mesohabitat will be described using a modified Brusven index system (Table 2). Our qualitative description is composed of a 2 digit substrate descriptor code based upon dominant and subdominant substrate types (x.y). Estimates will be compared to actual measurements taken in the same mesohabiats by USBOR during the expanded study.

- **Cover**

  Cover shall be defined as any structure that could potentially be used as escape cover from predation or provide shade. Cover will be classified using a three digit code (x.y.z). The first letter defines overhead cover that would provide shade or protection from predators within the mesohabitat. The second describes the size of the largest object providing cover within the mesohabitat. The third describes the quality or density of cover within the mesohabiat.

- **Shear**

  For the purpose of this study shear is synonymous with feeding stations or habitat that provides low velocity holding habitat adjacent to higher velocity feeding habitat. Shear can be either vertical or lateral in nature. Lateral shear habitats can be created by LWD, instream brush, boulders, or man made structures. Vertical shear habitats can be created by large substrate or abrupt changes in bed elevation. As quantitative measurements of shear within mesohabitats is not feasible given the limited time available, estimates will be made. Shear will be characterized on a scale of 0 to 3 (Table 2). When possible, FFC estimates will be directly compared to actual measurements taken by USBOR during the scale up study.

- **Edge type**

In each habitat, the dominate edge type will be determined by crew 1. The type of edge will be described using the following classification system.
0 – no edge
1 – bank
2 – undercut bank
3 – overhanging vegetation
4 - rootwad
5 – large wood
6 – non-emergent rooted aquatic vegetation
7 – fine organic substrate
8 – grass
9 – bushes
10 – boulders

Table 2. Microhabitat classification for Stanislaus River mesohabitats.

Depth	Substrate	Cover	Shear
0<1foot	1=silt, organic matter	**x**	
1=1-3 feet	2=sand	0=none	0=0-25%
2=3-5 feet	3=gravel	1=instream	1=25-50%
3>5 feet	4=cobble	2=overhead	2=50-75%
	5=boulder	3=instream and overhead	3=75-100%
	6=bedrock	**y**	
	7=riprap	0=none	
		1<6”	
		2=6-12”	
		3>12”	
		z	
		0=none	
		1=0-25% (poor)	
		2=25-50% (fair)	
		3=50-75% (good)	
		4=75-100% (excellent)	

Since the images are orthorectified, any digitized polygons can be overlaid using GIS on the original image. GIS can then be used to assign spatially–variable attributes of depth, velocity, substrate, vegetation (cover) for each cell. The 2-D boundaries of each cell will be determined for each flow regime encountered in the surveys by marking boundaries on aerial photos with boundaries based on visible habitat characteristics. Maps generated during this task will be used to select fish sampling locations.

3.1.3 Fish Surveys

The survey methodologies will include snorkel surveys where visibility allows and electrofishing[1] or seining where visibility does not allow snorkeling. Based on experience, snorkeling becomes difficult in the lower river downstream of Oakdale, therefore we believe it may be necessary to use back-pack and/or boat electrofishing gear if the lower river is to be covered. Seines would not be effective as much of the habitat is deep or heavy with debris. The permit application is in the process review by NOAA Fisheries staff and should be complete by Winter of 2008. Polygons in center-river below Oakdale will use average catch statistics for screw trap data if possible. Daily catch will be converted to 2-D area of polygons by converting screw trap data to per unit area from velocity/volume measurements.

Fish densities and temperatures shall be recorded in each mesohabitat polygon. Two highly trained divers will conduct all fish surveys. Prior to each days survey, each diver will undergo a 0.5 hour calibration exercise to improve size and density estimates. The training will be done in accordance with Thurow 1994.

For the edge polygons, snorkelers shall enter the water downstream of the mesohabitat to be surveyed and proceed upstream slowly avoiding sudden movements so as not to startle fish (Heggenes and others, 1990). To ensure complete coverage of the mesohabitats, snorkelers should survey in a zig zag pattern from the polygon midline. Fish should be counted as the snorkeler passes them to avoid duplicate counts (Thurow 1994).

No edge polygons will be surveyed downstream as depths will likely prohibit upstream movement. In this case, the number of divers will be dictated by the width of the polygon and water clarity. Up to three divers will survey the mid channel by floating downstream through the unit. Divers will maintain optimal lateral separation and longitudinal consistency with spacing poles constructed of 5 foot lengths of PVC. A person on the bank will stand at the downstream boundary and inform the divers when the boundary is reached.

Fish observations within mesohabitats will be recorded on separate dive slates. Variables recorded will include fish species and length. Size ranges for salmonids will be as follows: 30-50 mm (fry); 50-70 mm (fingerlings); 70-90 mm (presmolts); 90-120 mm (smolts); 120-200 mm (advanced smolts); and 100-mm groups thereafter. Size ranges for non-salmonids will be <25 mm; 25-50 mm; and 50-mm groups thereafter. For large groups of fish, size distribution was estimated as percentage by size category. Individual large salmonids will be counted and sized independently of smaller trout and salmon. The number of each species and life stage per 100 square meters surveyed for the entire site will be calculated to provide an index of abundance for each species and age

[1] Use of electrofishing gear may be problematic if permission cannot be obtained from DFG or NMFS. It may also be possible to use other available permits already existing among agencies or contractors.

group (salmon and trout). Because the area surveyed for each mesohabitat will differ, total observations will be standardized to a 100 square-meter index.

Sampling survey data will be represented for each survey by reach and by sample unit on GIS rectified aerial photos delineated for sample location via GPS locations recorded in survey sampling. Data will be presented by density per unit area of species and size groups within species for all sampled units.

3.1.4 Data Analysis

This is primarily a characterization of river structure and rates of change of habitat and fish distribution between two flows. It is descriptive rather than experimental and requires descriptive statistics for the most part. However, when comparing the ecological responses to distinct flow regimes and assessing whether differences in rates and distributions are apparent—and related to the distinct flow patterns (H_1 and H_2)—tests for differences between the descriptors are necessary. In this case, we may consider the two flows as two “treatments” and use standard techniques for paired comparisons where observations for one treatment are compared with the observations for the second treatment. Two techniques are available for testing the differences between the “treatments” in this situation. First, in such comparisons, we can legitimately arrange the data as a two-way anova (analysis of variance). Because we have only two treatments, this takes the form of a paired comparison test. The other method of analyzing paired comparisons designs is the t-test for paired comparisons. It is simple to apply and tests whether the mean of sample differences between pairs of observations is significantly different from a hypothetical mean, which the null hypothesis puts at zero. The standard error over which this is tested is the standard error of the mean difference.

For this work, a combination of the two tests should be used. While the paired comparison t-test is the common way of solving this type of problem, the two-way anova has the advantage of providing a measure of the variance component among the paired observations. For such ecological problems, the two-way anova might provide a clearer distinction among treatment outcomes. However, these tests require a rather strict set of assumptions to be satisfied; these assumptions may not be met by the ecological variables to be evaluated. For example, direct comparison among flow regimes for fish density may not be possible because different species and life stages are likely to occur during the two survey periods. In that case, there are some non-parametric tests that can be used in this paired analysis in place of the analyses discussed above.

3.2 2-D Hydrodynamic and Habitat Models

This section contains a brief discussion of 1) the study site, 2) physical habitat modeling methods (e.g., hydrodynamics model, substrate maps, cover maps, habitat type maps, etc.), and 3) biological habitat modeling methods (e.g., algorithms and suitability criteria).

3.2.1 Study Site

Two study sites, each a quarter mile long will be selected on the LSR. The sites will be chosen to incorporate a variety of habitat representative of important fish habitat types in the Stanislaus River and will overlap entirely with an empirical mapping section of river.

3.2.2 2D Physical Habitat Modeling

Modeling 2D physical habitat (depths, velocity, substrate, cover, etc.) consists of 1) generating a detailed digital terrain model (DTM) of the study site, 2) collecting substrate, cover and habitat type polygons to overlay onto the DTMs for modeling hydraulic roughness and for modeling fish habitat, 3) collecting water surface calibration data, and 4) 2D modeling of flow fields over a wide range of flows.

3.2.3 Digital Terrain Models (DTMs)

Detailed in water and out of water topography at the 2D site will be collected using the most appropriate combination of conventional total stations (Leica), robotic total stations (Trimble), laser-based (Arcsecond) surveying methods, GPS coupled sonar and/or aerial photogrammetry methods. Data will be collected on an irregular grid (points selected to best describe the topography). Survey control points and/or aerial photography targets will be established at the site in the UTM coordinate system. All large substrates (e.g., boulders and logs) will be included in the topographic survey. Where sharp breaks in topography existed, additional data will be collected as necessary to accurately define the topography. The surveyed topography from the different survey methods will be combined and carefully reviewed in 3D soft copy photogrammetry software
for completeness and errors. Where necessary the topography will be visually edited to control triangular-irregular-network (TIN) faces to accurately represent the surveyed topography and to add an artificial inflow and outflow channel at the inflow and outflow boundaries of the actual channel to facilitate numerical modeling.

3.2.4 Substrate and Cover and Habitat Type Characterization

Substrate, cover and habitat type polygons will be drawn on orthophotographs of the entire study site. Substrate polygons will consist of patches of similar substrate. Substrate polygons will be characterized by percentages of the example substrate types shown in Table 1. The exact substrate types will be determined by the Instream Flow Working Group (IFWG). Substrate polygons will be used to provide roughness to the 2D hydrodynamics model and for fish habitat for some species/ life stages. In addition, cover (e.g., vegetation) and habitat type (pool, run, riffle etc.) and spawning substrate polygons will mapped. These data will be used for spawning habitat and cover and habitat type criteria for biological modeling of the various species/life stages. An example of some cover types used on the McKenzie River and on the Klamath River is shown in Table 2. Cover types will be determined by the IFWG as part of this work.

3.2.5 Water Surface Data

Detailed water surface profiles on both sides of the stream will be collected at three different flows at the study site for hydraulic model calibration and validation.

3.3 2D Hydrodynamics Modeling Over a Wide Range of Flows

The 2D hydraulics modeling consists of 1) selecting a 2D hydrodynamics model, 2) generating computational meshes, 3) water surface modeling, 4) velocity and depth modeling, and 5) velocity and depth validation.

3.3.1 2D Hydrodynamics model

Although a number of 2D flow models could potentially be used for modeling, in this case we will likely use River2D (Steffler and Blackburn 2001). The model relies on 3-dimensional riverbed topography, flow rate, and downstream stage (i.e., water surface elevations) boundary conditions to calculate flow, velocities, water surface elevations and boundary shear stresses in the channel. It can be used in channels with or without side channels in both high and low Froude number flows (i.e., sub-critical and super-critical flow conditions). The model solves the 2D vertically averaged flow equations on a triangular irregular network (TIN) grid using a finite element scheme. It uses a spatially variable, scalar kinematic eddy viscosity turbulence closure based on substrate roughness height that emphasizes vertical diffusion of momentum. The program handles wetting-drying and uses a groundwater solution to calculate groundwater flow as well as surface flow. Because of this, at low topography locations that are disconnected from surface flow, pooled water will accumulate. These isolated water locations were excluded from fish habitat analysis.

3.3.2 Computational Meshes

A TIN computational mesh will be created for each 2D site that has a much finer resolution within the channel and near floodplain than on the high flow floodplain. If needed, mesh resolution will also increased around boulders and complicated flow areas to enhance the quality of the flow solution in these areas. The mesh will be refined as much as possible without causing inordinate amounts of time (e.g., days) to complete a flow solution.

3.3.3 Water Surface Modeling

The 2D model is calibrated by scaling the substrate roughness height at the site (using the substrate polygons) so that modeled water surface elevations matched measured water surface elevations. Typically this adjustment is done at one flow by comparing the measured versus modeled water surface elevations. Subsequently the roughness height remains fixed and the remaining water surface profiles at different flows are used to validate that the water surface modeling is accurate. Downstream water surface elevations (boundary conditions) for the model will be supplied from a stage-discharge relationship developed at the downstream boundary from empirical data.

3.3.4 Velocity and Depth Modeling

Vertically averaged velocities are generated during the solution of the 2D hydrodynamics equations at each of the mesh nodes. Accuracy of modeled velocities and depths is primarily dependent on the accuracy of the channel topography and the accuracy of the modeled water surface elevations.

3.3.5 Velocity and Depth Validation Data

Velocity and depth will be measured across several cross-sections at the study site at a known flow. These data will be compared graphically to the modeled velocities to illustrate the quality of the velocity and depth solutions.

3.4 Biological Habitat Modeling

Habitat modeling consists of associating the physical habitat data with biological suitability criteria for each species and lifestage (or guild), using specific habitat modeling methods/algorithms, and then generating quantitative habitat model outputs at each flow.

3.4.1 Species and Life Stage Criteria

The species and life stages to be modeled will be determined by the IFWG and the fish species and life stages available in the river at the time of the empirical habitat and fish mapping. Table 3 shows an example of the suitability criteria for velocity, depth, substrate and distance to cover by guild (note that cover types are shown in Table 2) used on the McKenzie
River and velocity and depth suitability criteria used on the Klamath River. Table 1 also shows the cover suitability criteria used on the Klamath River. Nearly any combination or type of habitat criteria can be used for habitat modeling. The results from the empirical habitat mapping and fish density surveys will be used to generate the fish habitat modeling methods. These methods will be determined by the IFWG.

3.4.2 Habitat Modeling Methods

Habitat modeling is typically computed on a finer mesh (separate mesh) than the 2D hydrodynamics primarily to provide accurate distance to cover modeling. Depth and velocity are interpolated to the habitat mesh from the 2D hydrodynamics solutions, and then habitat suitability is computed for each habitat mesh node based on some combination of depth, velocity, substrate, distance to cover (at each flow) and habitat type. Habitat suitability criteria and habitat modeling methods will be developed by the IFWG. Software specifically for the 2D habitat modeling will be developed by USU to implement the habitat modeling algorithms. For each species, life stage or guild modeled, the habitat suitabilities for depth, velocity and substrate, distance to cover, etc. will be combined to produce a habitat suitability at each mesh point. These suitabilities can be binary .g.,1=completely suitable, 0=not suitable) or continuous. The combined suitability can then multiplied by the area associated with each habitat modeling point (cell) to create a usable area (UA) for each species, lifestage or guild.

3.5 Habitat Modeling Outputs

Empirically mapped habitat polygons will be overlaid onto the 2-D modeled habitat at the same flows the empirical data were collected. These results will be used to compare and contrast the results from the two different methods (empirical mapping and 2D modeling). These results can be used by the IFWG to determine future study designs, modeling methods etc. In addition, 2D habitat versus flow over the entire range of flows (e.g., 200 to 3,000 cfs) will also be generated for each species, lifestage or guild. Again, these data can be used to help determine future study designs.

4.0 References

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Appendix: Technical Procedures Manual

FISHERY FOUNDATION OF CALIFORNIA
TECHNICAL PROCEDURES MANUAL

STANISLAUS RIVER HABITAT USE INVESTIGATION

January, 2007

FISHERY FOUNDATION OF CALIFORNIA
TECHNICAL PROCEDURES MANUAL

STANISLAUS RIVER HABITAT USE INVESTIGATION

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January, 2007

Purpose of the Manual

The purpose of this manual is to provide a comprehensive methodology to map mesohabitats and collect microhabitat and fish data. The manual is intended for use as a training guide and reference text, primarily for Fishery Foundation of California (FFC), but the manual is also appropriate for use by other practitioners.

Purpose of the Study

To determine fish and fish habitat response to different operational flows from New Melones Dam into the LSR and to conduct a preliminary investigation to test survey methods, validate the data analysis approach, and define how best to expand the effort to the entire LSR between Goodwin Dam and the confluence with the San Joaquin River.

1. Select five, one-half mile sample reaches between Goodwin Dam and the San Joaquin River.

2. Create ArcMap GIS maps of macro and meso habitat cells (polygons) for 5 sample reaches during two flows and classify each polygon using an acceptable classification system.

3. Measure density, length frequency, and species composition of fish within polygons.

4. From the data collected for each element above, create GIS database with layers that describe habitat and fish variables within polygons

5. Statistically describe variability in habitat use, availability, and quality within survey reach, among reaches, and within and among survey periods (flows).

6. Test a 2D hydrodynamic and habitat modeling approach at one reach during two flows.

Site Selection

Per stakeholder suggestions the LSR will be broken down into 3 segments. The first step in mapping mesohabitats is selecting a minimum of five stream reaches within these segments that possess the following:

5. Stream reaches must be approximately 0.5 miles in length.

6. Reaches must be reasonably representative of the larger stream segment in terms of ambient habitat.
7. Reaches must be void of hazards deemed too great by the safety manager.
8. Reaches must have reasonable access so that work can be carried out within the allotted time.

It is usually impossible to meet all of the above criteria. In such cases, FFC will select the best possible reach using the above criteria. Final sites are as follows:

Segment 1 (RM 47-58):

1. Two Mile Bar (0.5 miles),
2. Knights Ferry (0.5 miles),
3. Lovers Leap (0.5 miles),

Segment 2 (RM 34-47):

4. Orange Blossom Bridge (0.5 miles),
5. Oakdale (0.5 miles),

Segment 3 (RM 0-34):

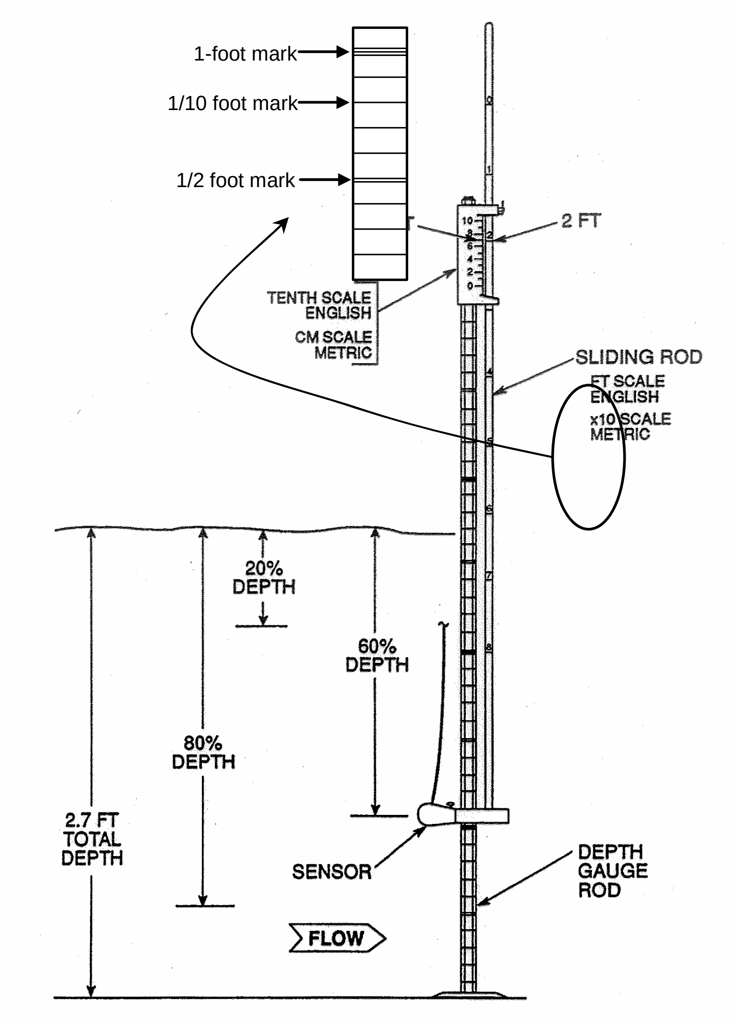
6. McHenry Recreation Area (0.5 miles),

Equipment

Velocity Meters

FFC currently accepts the use of either Marsh-McBirney or SONTEK FlowTracker velocity meters. Other velocity meters may be used for FFC projects with prior approval of the Project Manager. All meters used for FFC projects must have certification of calibration no more than 4 months old.

Top Setting Wading Rod



The standard USGS Top Setting Wading Rod designed for measuring shallow streams, with the standard English rod marked in feet and tenths and comes in 4, 6 and 8-foot models. The anodized aluminum handle has an integral scale to indicate the correct setting of the current meter at the 0.2, 0.6 and 0.8-depth settings, which corresponds to the conventional two- position method. This unit permits convenient setting of the current meter at the proper depth. It allows the hydrologist to quickly set the meter at the correct depth without bringing the meter out of the water. The depth of the water is read on the graduated hex main rod. When the round setting rod is adjusted to the depth of the water, the current meter is automatically positioned for the 0.6-depth method (0.4-depth position up from the streambed). Setting the unit to half the water depth will place the meter at the 0.2-depth up from the streambed. Conversely, setting the unit to twice the water depth will place the meter at the 0.8-depth position up from the streambed. The latter two positions correspond to the conventional two-position method.

Depth Rod

The depth rod will be used by divers during the mapping exercise to better estimate average depths within defined mesohabitat polygons. The rods are constructed of 3/4 inch pvc and are marked in feet and tenths after the top set wading rod.

Laser Range Finder

The FFC will use a KVH Datascope rangefinder to determine mesohabitat lengths and widths. The unit houses an integrated compass that will also be used for determining offsets when local GPS coverage is not available near polygon boundaries.

Global Positioning System (GPS)

Mesohabitat boundaries will be recorded using a Trimble Geo XH (2005 series) Hand held unit. Appropriate data dictionaries will be created and uploaded into the unit prior to mapping exercises. Post processed data will be downloaded into Arc GIS for mapping.

Onset Hobo Temp Dataloggers

Temperature loggers will be deployed at all reaches for the duration of the survey and will be set to record at 1 hour intervals.

Hanna Instruments 93703 portable Turbidity Meter

The field crew will record turbidity at all reaches prior to and after each fish density snorkel survey. Turbidity will be recorded onto fish density data sheets.

Data Sheets

Separate data sheets will be used for mesohabitat mapping, fish surveys, and GPS recording (Appendix A). Initially, habitat data will be written on tyvek tags placed at mesohabitat boundaries by the habitat survey crew. The GPS survey crew will transcribe the data from the tags onto Rite in Rain data sheets prior to marking boundary points as they follow the habitat crew upstream.

Fish data will first be written onto dive slates worn on the divers' wrist. Data will be transferred onto Rite in Rain data sheets at regular intervals or when there is no additional space on the dive slate.

GPS data will be stored in data dictionaries but will also be recorded onto data sheets so that redundant data is available in the event that the GPS unit is damaged or lost.

0

Site: Date:

Mesohabitat #___________

Depth ___ ___ ___
___ ___ ___

Substrate__________

Cover___________

Shear___________

Fish and Habitat Surveys

Mesohabitat Mapping

- ***Mesohabitat Boundary Determination***

Six mesohabitat types are proposed based on three water velocity categories and two categories for distance to edge (Table 1). Mesohabitat labels will follow an x.y code system based upon categories of the aforementioned variables (table 1). For example, a medium velocity, edge habitat would be classified as 1.1.

Table 1. Mesohabitat characterization criteria.

Velocity	Edge
0=0-0.5 fps	0=no edge (>2m from edge)
1=0.5-2.0 fps	1=edge (<2m from edge)
2=>2.0 fps	

One crew member (crew 1) will be responsible for determining mesohabitat boundaries and for measuring microhabitat variables within mesohabitats. Confining these activities to one highly trained person will, we assume, reduce observer bias that is often seen within multi person habitat surveys (Salow and Cross, 2004.). Crew 1 shall carry with him/her 50, pre-labeled, tyvex tags, Sharpie pens, and a depth rod.

Habitat surveys will start at the bottom of the 0.5 mile reach and proceed in an upstream direction. The two general mapping locations within a reach are those within 2 meters of an edge and those greater than 2 meters from an edge. Edge mesohabitat boundaries will be set based upon two criteria on the longitudinal axis and one for the lateral axis. Longitudinal margin boundaries will be set based velocity. Lateral edge boundaries or polygon widths will be set two meters from the nearest edge object. Longitudinal mid channel mesohabitat boundaries will be chosen primarily based upon velocity. Lateral no edge boundaries will be set by default at the edge boundary. Crew 1 will mark the upstream boundary of each mesohabitat with a tyvek tag. Irregularly shaped mesohabitats may be flagged and measured to capture the variability.

After each mesohabitat boundary is determined, crew 1 will survey the mesohabitat for microhabitat variables. Microhabitat variables will be written to a dive slate and transferred to the tyvex tag marking the upstream boundary. This process will continue upstream to the top of the reach.

- ***Microhabitat characterization***

Microhabitat variables within pre-defined mesohabitats will be estimated by the responsible crew 1 following mesohabitat boundary determination.

- ***Depth***

  Depth estimates will be determined both visually and with the aid of a depth rod (sec. 2.2). A minimum of six depths will be taken along the length of each mesohabitat. Depths will be taken in a zig zag pattern approximately 1 foot from the margin and one foot from the inside polygon boundary. Ave depths will be calculated at the end of the survey and assigned a category number (Table 2).

- **Substrate**

  Substrate will be visually categorized by crew 1 along the length of each mesohabitat polygon. Substrate composition in each mesohabitat will be described using a modified Brusven index system (Table 2). Our qualitative description is composed of a 2 digit substrate descriptor code based upon dominant and subdominant substrate types (x.y). Estimates will be compared to actual measurements taken in the same mesohabiats by USBOR during the expanded study.

- **Cover**

  Cover shall be defined as any structure that could potentially be used as escape cover from predation or provide shade. Cover will be classified using a three digit code (x.y.z). The first letter defines overhead cover that would provide shade or protection from predators within the mesohabitat. The second describes the size of the largest object providing cover within the mesohabitat. The third describes the quality or density of cover within the mesohabiat.

- **Shear**

  For the purpose of this study shear is synonymous with feeding stations or habitat that provides low velocity holding habitat adjacent to higher velocity feeding habitat. Shear can be either vertical or lateral in nature. Lateral shear habitats can be created by LWD, instream brush, boulders, or man made structures. Vertical shear habitats can be created by large substrate or abrupt changes in bed elevation. As quantitative measurements of shear within mesohabitats is not feasible given the limited time available, estimates will be made. Shear will be characterized on a scale of 0 to 3 (Table 2). When possible, FFC estimates will be directly compared to actual measurements taken by USBOR during the expanded study.

- **Edge type**

In each habitat, the dominate edge type will be determined by crew 1. The type of edge will be described using the following classification system.
0 – no edge
1 – bank
2 – undercut bank
3 – overhanging vegetation
4 - rootwad
5 – large wood
6 – non-emergent rooted aquatic vegetation
7 – fine organic substrate
8 – grass
9 – bushes
10 – boulders

Table 2. Microhabitat classification for Stanislaus River mesohabitats.

Depth	Substrate	Cover	Shear
0<1foot	1=silt, organic matter	**x**	
1=1-3 feet	2=sand	0=none	0=0-25%
2=3-5 feet	3=gravel	1=instream	1=25-50%
3>5 feet	4=cobble	2=overhead	2=50-75%
	5=boulder	3=instream and overhead	3=75-100%
	6=bedrock	**y**	
	7=riprap	0=none	
		1<6”	
		2=6-12”	
		3>12”	
		z	
		0=none	
		1=0-25% (poor)	
		2=25-50% (fair)	
		3=50-75% (good)	
		4=75-100% (excellent)	

GPS Boundary Marking

Crew 2 will follow crew 1 to record the GPS coordinates for the mesohabitat polygons and to transcribe the data from the tyvex margin tags to rite in rain data sheets. Crew 2 will be made up of one person on a kayak and one diver. The kayakers’ responsibility will be to record GPS coordinates at each of the mesohabitat boundaries, to transfer data from the margin tags, and determine lengths and widths with a laser range finder. The divers primary function is to provide a target for the range finder. Additionally, the diver will determine lateral mesohabitat boundaries by locating the lateral point at which the velocity abruptly changes.

Crew 2 will move upstream to gather data when velocities allow and downstream when velocities prohibit upstream movement. Surveys may also be conducted on foot when conditions instream are unsafe for kayaking. Responsibilities for crew 2 shall be conducted in the following order:

1. Mesohabitat and microhabitat data recorded on the tyvex boundary tags will be transcribed to rite in rain data sheets which shall then be stored in a waterproof folder.

2. GPS coordinates shall be recorded at the top and bottom of each mesohabitat. If a polygon is irregularly shaped, a mid point shall be taken. Points shall be taken at the river margin when GPS coverage allows. When GPS coverage is not available, crew 2 shall move to a more favorable location and take a compass offset and a distance for later correction.

3. Crew 2 shall measure the length of the polygon and measure widths at the top, bottom, and, if applicable, the middle of each mesohabitat polygon. Lengths and widths of the polygon will be determined by a range finder. The crew member in the kayak will use the tag locations as markers to determine the length of the polygon using the range finder. The diver at the bottom of the polygon will hold their position at the tagged boundary. By holding position at the top of the polygon where the tag is located, the kayaker will use the diver at the bottom of the polygon as a target to "shoot" with the range finder. This information will be recorded on the GPS data sheet.

   Widths of margin polygons will be determined by the diver in the water. To determine the width, the diver will hold him/herself two meters from the edge. Using the range finder the kayaker or person on the bank will "shoot" the diver to determine the width of the polygon at each point and record the data on the data sheet. This will be done at the top and bottom of every polygon. For polygons with an irregular shape, widths will be taken in the middle of the polygon as well.

   Longitudinal mid channel boundaries will be determined by the diver and marked with tags on the bank. The information on the tags will be recorded by the kayaker. Latitude and longitude will be taken by a GPS unit and recorded on the data sheets. If satellite reception is not available, an offset will be taken. Lateral mid channel no edge boundaries will be set to the edge boundaries by default.

Fish Density Surveys

Fish densities and temperatures shall be recorded in each mesohabitat polygon. Two highly trained divers will conduct all fish surveys. Prior to each days survey, each diver will undergo a 0.5 hour calibration exercise to improve size and density estimates. The training will be done in accordance with Thurow 1994.

For the edge polygons, snorkelers shall enter the water downstream of the mesohabitat to be surveyed and proceed upstream slowly avoiding sudden movements so as not to startle fish (Heggenes and others, 1990). To ensure complete coverage of the mesohabitats, snorkelers should survey in a zig zag pattern from the polygon midline. Fish should be counted as the snorkeler passes them to avoid duplicate counts (Thurow 1994).

No edge polygons will be surveyed downstream as depths will likely prohibit upstream movement. In this case, the number of divers will be dictated by the width of the polygon and water clarity. Up to three divers will survey the mid channel by floating downstream through the unit. Divers will maintain optimal lateral separation and longitudinal consistency with spacing poles constructed of 5 foot lengths of PVC. A person on the bank will stand at the downstream boundary and inform the divers when the boundary is reached.

Fish observations within mesohabitats will be recorded on separate dive slates. Variables recorded will include fish species and length. Size ranges for salmonids will be as follows: 30-50 mm (fry); 50-70 mm (fingerlings); 70-90 mm (presmolts); 90-120 mm (smolts); 120-200 mm (advanced smolts); and 100-mm groups thereafter. Size ranges for non-salmonids will be <25 mm; 25-50 mm; and 50-mm groups thereafter. For large groups of fish, size distribution was estimated as percentage by size category. Individual large salmonids will be counted and sized independently of smaller trout and salmon. The number of each species and life stage per 100 square meters surveyed for the entire site will be calculated to provide an index of abundance for each species and age group (salmon and trout). Because the area surveyed for each mesohabitat will differ, total observations will be standardized to a 100 square-meter index.

References

Heggenes, J.; Brabrand, A.; Saltveit, S.J. 1990. Comparison of three methods for studies of stream habitat use by young brown trout and Atlantic salmon. Transactions of the American Fisheries Society. 119: 101-111.

Thurow, R. F. 1994. Underwater methods for study of salmonids in the Intermountain West. U.S. Department of Agriculture, Forest Service, Intermountain Research Station. General Technical Report INT-GTR-307. Ogden, Utah.

Appendix A

Stanislaus River Habitat Use Investigation

Mesohabitat Data Sheet

Date: **Reach:** **Crew:** **Flow:**

Habitat Types												
Macro	Meso	Depth (ft)	Substrate	Cover	Shear	Length	Top Width #1	Mid Width# 2	Bot Width# 3	Average Width	Area	Code

Macrohabitats: 0: Low velocity (0-0.5fps) 1: Med velocity (0.5-2.0fps) 2: High velocity (>2.0fps)
Mesohabitats: 0: No edge (>2.0 meters from edge),
1: edge (<2.0 meters from edge)
Edge type; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Depth: 0: <1ft, 1: 1-3ft, 2: 3-5ft, 3: >5ft

Substrate (x.y): 1:silt, organic matter (<0.062mm) 2: Sand (0.062-4mm) 3: Gravel (4-75mm) 4: Cobble (75-300mm)
5: Boulder (>300mm) 6: Bedrock 7: Rip-Rap

Cover (x.y.z): 0=none 1=instream 2=overhead 3=instream and overhead; 0=none 1=<6" 2=6-12" 3=>12';
0=none 1=0-25% 2=25-50% 3=50-75%
4=75-100%

Shear: 0:Zero 1: Slight, 2: Moderate, 3: High

Entered By:

Checked By:

Fish Density Data Sheet

Stanislaus River Habitat Use Investigation

Polygon	Species	Number	Length	Polygon	Species	Number	Length

Reach:

Date:

Crew:

Flow:

Temp:

Start

Turbidity:

*Length C
30-50
51-70
71-91
91-120
120-200
200-300
300-400
400-500
500-600
>600

Entered B

Checked E